THE Chemist

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What Happens When a Lamp Shop Goes to War

Over 2200 employees of Corning Glass Works have entered the Armed Forces. But the men Corning could least afford to lose, the ones hardest to replace, are the lamp shop craftsmen.

For despite automatic machines, despite improved glass making techniques, hand work still plays a most important part in the making of laboratory glassware.

It is in the lamp shop that most of this hand fabrication is done. Here is where the skill of the glass blower is at its highest. Here is where experience counts most. Streamlined production and speed assembly lines are out of the question here.

Since the outbreak of the War, the lamp shop has been one of the busiest spots at Corning Glass Works. Operating twenty-four hours a day, it still faces an enormous backlog of high priority orders.

That is why, temporarily, you may have to wait for Pyrex, Vycor or Corning brand glassware that may require lamp shop fabrication. That is why delivery on special items may be delayed.

When Peace returns, and lamp shop operation becomes normal, Corning craftsmen can apply their skill and increased knowledge to the fabrication of special apparatus for the Nation's laboratories.

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1920

The Contributions of Fermentation Chemistry to National Economy

C. L. Gabriel, F.A.I.C.

Publicker Commercial Alcohol Company

Presented at the New York Chapter (A.I.C.) Meeting held Jan. 26th.

IT IS not generally realized, even by chemists and chemical engineers, how important a place in our economic system is occupied by the products of the fermentation industries, without including foods and beverages such as cheese, vinegar, pickles, sauerkraut, yeast, whisky, wine and beer. Some of the industrial products made by fermentation stand close to the top in volume in any list of organic chemicals that can be prepared and not only have a far-reaching influence on our economics in normal times, but also are absolutely necessary to our war effort.

Ethyl Alcohol

First on the list of important chemicals produced by fermentation is ethyl alcohol. This product is produced by fermenting an aqueous solution of sugar using yeast as the inoculant. The sugar may be in the form of by-product molasses from cane or beet sugar refining, or it may be produced by hydrolyzing starch containing grains or vegetables with an enzyme or an acid, or by the hydrolysis of wood cellulose. When the fermentation is complete, high grade 190-proof or 95 per cent alcohol is obtained from the fermented mash by distillation.

In normal years, before the present war, the annual production of ethyl alcohol usually ran between 100,000,000 and 125,000,000 gallons of 95 per cent material. As alcohol weighs 6.8 pounds to the gallon, a minimum of 350,000 tons annually was produced during the late nineteen-thirties.

With our entrance into the Second World War, it was necessary greatly to expand our production of ethyl alcohol, due to the need of an alcohol-ether mixture for the gelatinization of nitro-cellulose in making smokeless powder, and also because this country was cut off from its supplies of natural rubber, so that it was necessary to establish, as quickly as possible, a synthetic rubber industry.

Our industrial alcohol plants running at full capacity could not possibly meet the increased demand. To add to the difficulty, shipments of black strap molasses almost came to a standstill during the months when U-boats were most active off our shores.

It was, therefore, necessary that most of the plants which produced alcohol by fermentating black strap be equipped to utilize grain instead of molasses. This meant the installation of much additional equipment for unloading, grinding, cooking, cooling and malting the grain. It was also necessary to install evaporators, dryers and auxiliary equipment for recovering the dry cattle food from the fermented mash from which the alcohol had been distilled. This had to be done, both to protect the channels and water supplies of rivers, and to increase the supply of much-needed cattle feed.

All distilleries were ordered to discontinue the production of distilled alcoholic beverages and to make only 190-proof alcohol for industrial use. It was necessary to install additional distilling equipment in many plants so that this high-proof product could be made, In many cases, small distilleries which only made whisky and were not equipped to make high-proof spirits had to ship their products to other plants to bring up the alcoholic strength to 95 per cent. A few small fermentation plants were built and the capacity of synthetic alcohol production was approximately doubled. As a result of all these efforts, about 600,000,000 gallons of 95 per cent ethyl alcohol were produced in 1944, of which approximately ten per cent was synthetic. Thus the production of ethyl alcohol amounted to the astounding figure of 2,000,000 tons, practically all of which was produced by fermentation.

The alcohol fermentation industry also had to overcome other difficulties. The grain usually used for such fermentations is corn, but there was an exceedingly short supply, so that most distillers had to use wheat. New techniques had to be devised for handling wheat so that yields comparable to those obtained from corn could be achieved. Under the pressure of war, experiments ordinarily tried on a small scale had to be carried out in the plant in order to speed up the production schedule.

More than fifty per cent of the alcohol produced in 1944 was used in making butadiene and styrene for synthetic rubber, the amount used for styrene being relatively small compared to that required for butadiene production. About seventy-five per cent of the butadiene produced from the start of the synthetic rubber program, through most of 1944, came from alcohol. Our synthetic rubber program would have been hopelessly delayed had it not been for this production of butadiene from alcohol. The next largest use for alcohol during the war was, of course, in the making of smokeless powder.

On January 18th, the War Production Board estimated a consumption of 655,000,000 gallons of alcohol in 1945, of which 603,000,000 will be produced, and the balance will

be taken from the government stockpile of 81,000,000 gallons. Consumption is estimated in millions of gallons as 105 for direct military and Lend-Lease, 349 for synthetic rubber, 165 for indirect military and civilian, and 36 for anti-freeze.

In normal times, the chief uses for ethyl alcohol are anti-freeze, the production of acetic acid and ethyl acetate as a solvent for use in the paint and varnish industry and for resins in making laminated board, and in the production of dye stuffs, pharmaceuticals, perfumes, flavoring extracts and vinegar. It is evident that although industrial alcohol, except when denatured for anti-freeze purposes or shellac solvent, rarely is purchased by the ordinary individual, he nevertheless constantly comes in contact with products which contain or in the production of which there is used this important organic chemical.

According to figures available in the *Oil, Paint & Drug Reporter,* the price of specially denatured alcohol varied between 22 cents and 27 cents per gallon in tank cars, delivered between 1937 and 1941. Present prices are substantially higher due to the fact that the government is paying practically sugar prices for black strap molasses, and because the greater part of fermentation alcohol is being made from expensive grains to meet the wartime demand. It can be expected that when normal times again come, the price of molasses will be low.

Black strap molasses is a by-product. If it has no market, it is an expense to the sugar producer, as it must be taken out to sea and dumped. To retain his market, the sugar producer must be willing to sell black strap at a price sufficiently low to enable the alcohol manufacturer to produce ethyl alcohol in competition with the synthetic product. The increase in synthetic alcohol plants' production to a capacity of 45 to 55 per cent of the pre-war consumption of the country is practically assurance that the price of black strap molasses will again be reasonable after the war ends.

It is important to bear in mind that ethyl alcohol is produced by fermentation from products which can be grown year after year as opposed to synthetic production, which in the years ahead will be dependent on a waning oil supply and an increase in raw material costs due to higher-priced petroleum produced naturally or by the hydrogenation of coal.

Butyl Alcohol

From the standpoint of volume and its contribution to our national economy both in peace and war, the fermentation process which produces butyl alcohol with acetone as a by-product ranks next. This process was first started in the United States shortly before the end of the last war. It was used not to produce butyl alcohol, but rather to make acetone which was sorely needed by the Brit-

ish as the solvent in gelatinizing their smokeless powders. The only other source of acetone at that time was the destructive distillation of wood in which process calcium acetate is produced. The dry distillation of the latter results in the formation of acetone.

After the war ended, the government-owned plants were acquired by a private company and were operated for the production of butyl alcohol about two pounds of which were obtained for each pound of acetone. Corn was the chief raw material used. It had been found that butyl acetate could be used in place of amyl acetate in nitrocellulose lacquers. The amyl acetate was made from fusel oil which is obtained as a by-product of alcohol fermentation. Most of it was imported.

During the first few years the market for butyl alcohol was small as relatively large stocks had been built up in the United States and Canada from the fermentation process operated during the war and had to be absorbed, and as the importation of fusel oil was fairly large considering the limited market for nitrocellulose lacquers. In 1922, a tariff of six cents per pound was placed on butyl alcohol which proved very helpful to this young industry.

However, what is more important is that in 1923, lacquers with a nitrocellulose and resin base were first applied to automobiles. This application of a quick drying finish which required hours instead of weeks to apply was of the greatest importance to the mass production of automobiles which was starting about that time. It is difficult to imagine the tremendous amount of floor space and labor which would be required to finish one-half million automobiles per month, if the finishing operation took two or three weeks as was the case with the oleoresinous finishes available at that time.

Within a year or two, practically all cars were being finished with lacquer and almost every paint and varnish producer found it necessary to enter the field to retain his business with the automobile manufacturers. The use of such finishes spread to other fields such as furniture, refrigerators, radios, and to other items where oil varnishes or enamels had previously been utilized.

The minute bacilli, which were inoculated into the sterile corn mash to produce butyl alcohol and acetone, were doing a tremendous job. However, much research work was being carried out toward finding other bugs which would do a similar job on cheaper raw materials, and in the early thirties, cultures were developed which would work on molasses and produce butyl alcohol and acetone in satisfactory yield. In fact, these were an improvement on the bacteria which worked on grain only as the new bacilli gave a higher ratio of butyl alco-

hol to acetone. Whereas in grain fermentations the mash was a perfect medium and required no additions, in molasses fermentations, additional nitrogen in the form of ammonia and phosphates must be added and the pH of the medium adjusted. The fermentation requires about thirty-six hours and the final mash contains about two per cent of solvents. A steam distillation brings this concentration up to 50 per cent and the butyl alcohol, acetone, and small percentage of ethyl alcohol are easily separated from each other in pure form by distillation.

Normal butyl alcohol also is produced synthetically from acetaldehyde made either from acetylene or ethyl alcohol. The acetaldehyde is condensed to aldol which is converted to croton aldehyde. On hydrogenation, the last-named material is converted to butyraldehyde and then to butyl alcohol. Although butyl alcohol has been made synthetically in this country for more than ten years, the greater part of the volume produced each year comes from the fermentation process. Most of the butyl alcohol found its way into nitrocellulose lacquers, chiefly in the form of butyl acetate. It was only natural that other forms of quick synthetic drying finishes should be developed with the result that new products, including the alkyd and the urea resins, should come into use often in competition with nitrocellulose lacquers.

However, the alkyds are used in large amounts in nitrocellulose and urea finishing materials. In addition, large amounts of butyl alcohol are used not only in making urea resins, for finishing materials, but as a solvent in the finishes themselves. As a result of all these developments, the annual consumption of butyl alcohol has increased almost continuously. Whereas in 1935 production approximated 36,000,000 pounds, this had increased to 100,000,000 pounds in 1940. While the largest use for butyl alcohol is as a solvent or as the acetate in finishing materials, it is utilized in many other important ways. Dibutylphthalate is an important plasticizer for various finishes, thermoplastics, and laminated phenolic board. Today tremendous amounts of dibutylphthalate are used in military explosives, so that under war conditions, probably more butyl alcohol is used in making this plasticizer than for any other purpose Dibutyl sebacate is the best plasticizer for vinyl butyral, sheets of which are used in making safety glass, so important to peacetime automobiles as well as in Army trucks and tanks.

When butyl alcohol is oxidized to butyraldehyde, a raw material is obtained from which important rubber accelerators are made, as well as vinyl butyral resins. The growth of the latter has resulted in a much greater consumption of butyraldehyde for making the resin than was ever used

for making the rubber accelerator. It is thus evident that butyl alcohol itself or in the form of its many derivatives has an important bearing on our economics.

Like ethyl alcohol and other fermentation products, butyl alcohol is chiefly made from materials which can be grown every year. In the early twenties butyl alcohol sold for about 24 cents per pound. During the last five pre-war years, it ranged from seven to nine cents per pound. Its price has consistently been lowered, as cheaper raw materials and increased production brought about reductions in costs.

Acetone

A word should be said about acetone, even though the fermentation material accounted for only about 20 per cent of the 1940 production. Again it should be borne in mind that the producer of butyl alcohol by fermentation uses cultures and conditions intended to hold to a minimum the ratio of acetone to butanol, as the latter is the more valuable product. About 1924, the production of acetone by fermentation was sufficient to take care of the needs of the country with the result that acetone ceased to be made from products of wood distillation, due to higher costs.

It is well known that acetone is synthesized by making isopropyl alcohol from propylene and oxidizing or dehydrogenating the alcohol. Figures show that while about 200,000,000 pounds of acetone were produced in 1940, only about 120,000,000 pounds were sold, most of the balance probably having been used for acetic anhydride and some less important acetone derivatives such as diacetone alcohol and mesityl oxide.

The chief uses of acetone twenty years ago were as an absorbent in acetylene cylinders and as a solvent in the production of photographic and moving picture film. The growth of the cellulose acetate industry—fibers, plastics and film — entirely changed the situation and the consumption of acetone more than kept pace with this growth. Acetone is used not only as a solvent in the cellulose acetate industry, but in addition, one large producer of synthetic acetone converts a great part of his production into acetic anhydride. When acetone vapors are heated at high temperatures, they are converted into ketene and methane. Direct action between ketene and glacial acetic acid produces acetic anhydride; thus the cellulose acetate industry utilizes acetone in two ways, as acetic anhydride is required for the acetylation of cellulose.

Whereas twenty years ago acetone was selling for about fifteen cents per pound, its price range between 1937 and 1940 was four and one-half to six cents per pound.

Butylene Glycol and Glycerol

From the standpoint of volume,

there are no other industrial fermentation processes as important as those previously mentioned. It is well known that both butylene glycol and glycerol can be made in substantial yields by fermentation. However, the recovery of these products which have boiling points above that of water is fairly expensive. In ethyl or butyl alcohol fermentations, a relatively low percentage of the solvent in the fermented mash is not too important economically as a single steam-stripping of the latter easily increases the concentration of the solvent in the aqueous distillate to 50 per cent and all the fermentation residues thus are separated in the same step from the alcohol or solvent. In the glycerol and butylene glycol fermentations, the separation of the desired product from both water and the non-volatile residue of the raw material used is not a simple problem.

Similar difficulties are encountered in obtaining pure products from most of the fermentations which produce organic acids, and for this reason, acids like acetic, butyric and propionic can be made more cheaply by catalytically oxidizing in the vapor phase the corresponding alcohols to their respective aldehydes, and further oxidizing the latter to the corresponding acids. However, acetic acid in the form of vinegar for special food purposes is made chiefly by oxidizing dilute alcohol by means of bacteria.

Lactic Acid

Outside of this fermentation, lactic acid is probably the most important acid fermentation which is carried out by means of bacteria. This is not a new process, as the fermentation was first recognized in 1847, and pure lactic organisms were first isolated in 1877. This fermentation process produced about 7,000,000 pounds of lactic acid—basis 100 per cent in 1943. Slightly more than half of this was for food purposes while the technical material found chief uses in the leather and textile industries. The acid usually is sold in solutions ranging from 22 to 80 per cent acid. The price of the edible product based on a 100 per cent acid content is about 25 cents per pound, while the technical grade is about half of this price. For the seven years preceding 1937, the price of lactic acid was about 60 per cent higher than the present schedule.

Citric Acid

The use of fungi or molds for industrial fermentations is relatively new in this country. It was known before the start of the twentieth century that certain fungi produced citric and oxalic acids when permitted to come in contact with sugar solutions, but in most cases, a mixture of the two acids was obtained, yields were not exceptionally good and there was a variation in the proportion of one acid to the other. In 1916, Thom and Currie published a paper on the as-

pergilis niger group which overthrew the idea that its members were exclusively oxalic acid formers. This was followed by an investigation by Currie on the production of citric acid by a selected strain of this mold. He found that by using about a 15 per cent aqueous sugar solution, supplying small amounts of nutrient nitrogen in the form of ammonium nitrate, and adjusting the initial pH of the culture solutions to 3.5 by the addition of hydrochloric acid, the formation of oxalic acid was almost completely suppressed and a rapid fermentation took place in which citric acid was formed.

About 1900, production of citric acid by mold fermentation was attempted on an industrial scale in Germany, but the difficulties encountered were so great that the process was not able to compete with acid recovered from citrus fruits. In the late twenties, this fermentation was started in this country as a result of intensive research work, and the exact method of carrying it out on a large scale is a closely guarded trade secret. It is felt that the process undoubtedly consists of a shallow pan fermentation of sugar by a strain of aspergilis niger and that the reaction is probably complete in less than nine days. The pad of fungi on each tray floats on top of the sugar nutrient broth in contact with air.

Whereas practically all the citric acid, either as such or in the form of calcium citrate, was formerly imported into this country, it is understood that the production of citric acid by mold fermentation over here is now sufficiently large not only to supply this country's needs but also to take care of exports. The last figure available indicates a production of slightly more than 13,000,000 pounds for 1939. The present price for this product in barrels is 20 cents per pound whereas in 1930, the price was 46 cents per pound or more than twice as high. The chief uses for citric acid are in making drugs and food products.

Gluconic Acid

Gluconic acid is another acid which is produced by mold fermentation. The fermentation is carried out in tanks or rotating drums and sterile air must be passed through the fermenting mash so the pressure in the vessel is about thirty pounds. Time of fermentation is two to seven days. Gluconic acid is chiefly used in pharmaceuticals, especially as calcium gluconate and as a raw material for making ribose for the synthesis of riboflavin or vitamin B_2. No production figures are available. The present price for the product is 12 cents per pound for 50 per cent material, as compared to 20 cents per pound for the eight years preceding 1940.

Penicillin

From the standpoint of general interest, the production of penicillin by molds stands out above all fermenta-

tion processes. This so-called "wonder drug" has aroused so much attention because of its outstanding antibiotic properties with respect to many organisms which have been the cause of countless deaths in the past. As penicillin appears to be especially effective in preventing infections caused by wounds, the present war brought about large-scale production of this product much more quickly than would otherwise have been the case.

As a result of Government sponsorship, various research and development groups, including the Northern Regional Laboratory, which had been working on penicillin, were brought together in order that the least time would pass before plants for making this material could be designed and put into operation. Operations chiefly from pilot plants began in this country in 1942, but it was not until toward the end of 1943 that production really began to get underway on a large scale. According to the War Production Board, the total production of penicillin was 9,000,000,000 units in December, 1943, while the output in December, 1944, was 290,000,000,000 units. Chas. Pfizer and Company, which is the largest producer of penicillin, and to whom I am indebted for some information on the process, had an average monthly production of 416,000 Oxford units in 1942. Production increased slightly during the year 1943 with 933,000 units being produced in January, 28,000,000 units in June, and 3,200,000,000 units in December. This trend was continued through 1944 with a maximum monthly figure being reached in December and amounting to slightly over 110,000,000,000 units or almost 40 per cent of the total production of the country for that month.

The production of penicillin is an extremely complicated process. This is especially true because relatively minute amounts of the desired substance are present at the end of the fermentation in the mash or broth in which the mold, Penicillium Notatum, does its work. Therefore, the recovering of the final product—a penicillin salt—is extremely difficult and it has involved some outstanding chemical engineering work. The final product must be of the highest purity not only chemically but also bacteriologically, as impurities may more than off-set the benefits which the patient would derive from penicillin. The fermentation broth contains an extremely low concentration of the potent substance—only 30 to 40 parts per million.

In the earlier work on the production of penicillin, the broth was placed in bottles of several liters capacity and inoculated. A sterile cotton plug was placed in the opening and the bottles were stacked on their sides so that the amount of broth was slightly less than 50 per cent of the capacity of each bottle. While this method is

still in use, it is evident that the tremendous output reached in December, 1944 could not have been attained had not a process been developed for handling thousands of gallons of broth in a single vessel. This process is termed deep-culture fermentation. The mold or mycelium grows only in the presence of air and it was for this reason, that bottles in which the mold grew on the surface of the broth were first used.

In deep-culture fermentation, the mold is supplied with air by running tremendous volumes into the bottom of each fermenter, where it is finely divided and distributed either by passing through porous plates or finely perforated nozzles. This air must be completely sterilized in order to prevent bacterial infection of the broth. A temperature of about 24°C is used during the fermentation. When the process is complete, the broth is run through filters to remove the mycelium, treated with activated carbon to absorb the penicillin and run through a filter-press to collect the carbon adsorbate. The latter, after being washed, is eluted with an 80 per cent solution of acetone in water. This solution is then subjected to repeated extractions with a water-immiscible solvent. The concentrated eluate is chilled to 0°C and acidified. Under these conditions, penicillin is readily soluble in amyl acetate.

The penicillin then is extracted continuously from this solvent solution with dilute sodium bicarbonate. These various solvent treatments are for the purpose of separating penicillin in as pure a form as possible from other products which are absorbed with it on the activated charcoal and to end up with a sodium penicillin solution. Needless to say, a considerable amount of equipment is required for the sole purpose of recovering the various solvents used in the process.

The sodium penicillin solution is next passed through filters to obtain a sterile and pyrogen-free product and is stored in sterile containers while the potency of the solution is being compared with that of pure crystalline penicillin.

All the operations which follow, until the finished product is packaged, are carried out in rooms which are air-conditioned and sterilized. Precautions to maintain sterility include clothing operators in a manner similar to that used in the most up-to-date operating rooms in hospitals. The humidity in the rooms is kept at about 10 per cent by using aluminum oxide to absorb moisture from the air.

After the potency of the sodium penicillin solution has been established, it is accurately measured into vials, by means of automatic filling machines, so that each will contain slightly in excess of 100,000 Oxford units of penicillin. The bottles are on aluminum trays during the filling operation and are then immediately

covered and transferred to a continuous freezing bath after which they are placed in drying cabinets kept under an exceedingly high vacuum. The cabinets are cooled by circulating liquid ammonia at -60°C in a jacketed condenser. The moisture of the final product is usually below one per cent. The vials are then sealed with sterilized and thoroughly dried rubber stoppers which are automatically covered with an aluminum seal.

The reason more details have been given on the penicillin process than on the other fermentation processes, is that it is the newest and most unique of our fermentations. Certainly no other fermentation process involves the recovery in pure form of a material which is present in the original broth in such minute quantities. There has been a substantial reduction in the price of penicillin as a result of the large increase and improvements in production. Whereas in 1942 the price was $20.00 per 100,000 Oxford units, it is now $1.50 per 100,000 Oxford units.

I am not an economist, but if I were one, I would hesitate to make any forecast as to the contribution which penicillin will make to our national economy. It is not only saving the valuable lives of many of our men in uniform, but in the near future, should be generally available for civilian use. The value of a human life cannot be measured in money. Lives saved mean increased population, resulting in larger demands for the products of agriculture and industry. This should mean more jobs and an improved economy.

Many fermentations are important sources of vitamins—yeast contains vitamins B_1, B_2 and D; butyl alcohol organisms produce B_2 and pantothenic acid; gluconic acid is a raw material for riboflavin, and sorbital can be fermented to sorbose from which ascorbic acid or vitamin C is made.

If we add the farm products used by other fermentation industries, such as beer, wine, distilled spirits, bakers and food yeasts, cheese and vinegar, to those required to supply raw materials for the industrial processes here mentioned, it becomes evident that year after year, the fermentation industry is an extremely important customer of the American farmer and of the sugar growers both in this country and abroad.

At various times, the idea has been set forth to take steps to eliminate or reduce the importation of black strap molasses so that certain industrial fermentations would substitute, for this raw material, grains grown in this country. Unfortunately, the most important fermentation products have to compete with synthetics. The normal market prices for grains are too high to permit the fermentation products to compete. The only results which would be obtained would be the elimination of the fermentation industries and the increased use of petroleum

Medal Award 1945

THE medal of THE AMERICAN INSTITUTE OF CHEMISTS, awarded annually for "noteworthy and outstanding service to the science of chemistry or the profession of chemist in America" is to be presented for 1945 to John W. Thomas, chairman and directing head of The Firestone Tire and Rubber Company, Akron, Ohio.

The award is made in recognition of Mr. Thomas' numerous personal scientific achievements and for his accomplishments in translating research results of the Firestone laboratories into large-scale production.

The new Firestone Research Laboratory, a two-million dollar project, being built under Mr. Thomas' personal direction and supervision, will be formally opened in the Spring.

The medal presentation will be made at the Annual Meeting of THE AMERICAN INSTITUTE OF CHEMISTS, to be held in Columbus, Ohio, on May 11th and 12th, with headquarters at the Deshler-Wallick Hotel.

gases, as ethylene, for the production of such products as ethyl and butyl alcohols; the American farmer would not be benefited by eliminating or restricting the imports of molasses.

In other words, to use American farm products for these fermentation processes, it would be necessary to subsidize grains so that they would be available at low prices to the non-food and non-beverage fermentation industries. Possibly it would be better to have such subsidies than to make payments to the farmers for not raising certain products. However, such matters are entirely in the hands of the law makers in Washington, as they are the people who must determine what is best for the country as a whole.

Because raw materials are renewable each year and because uses for finished products are constantly increasing in many manufacturing operations, the fermentation industry should continue to contribute on an expanding scale to our national economy.

Carothers at University of Alabama

J. N. Carothers, formerly director of research at Monsanto's Anniston plant, is in charge of the research work on sulfur organic compounds now under way at the University of Alabama. This work is financed by a direct grant from the State Legislature.

Post-War Inventions And Employment Contracts

Vanderveer Voorhees, F.A.I.C.

Chairman, Contracts Committee,
THE AMERICAN INSTITUTE OF CHEMISTS

The Committee on Contracts of the Institute is reviewing employment contracts and asks members of the Institute to send copies of these in confidence to the Committee. In addition to the accompanying article on the subject, the Committee plans to publish further reports and to make specific suggestions.

SO MUCH has been said about the importance of inventions in the post-war world and particularly the role of invention in averting a post-war depression that the subject of the rights of chemists to their inventions is particularly timely. When it is considered that the basic function of our patent system is to stimulate invention and the development of inventions by the grant of patents, serious thought should be given to the question of whether or not this function is being performed to the fullest extent under the prvailing practice of contracting to assign inventions before they are made.

When a chemist applies for a job or after he has been hired, he is frequently asked to sign a contract which relates primarily to the disposition of any inventions he may make. Sometimes the character of service he may render competitors after his term of employment has ended is also covered and, in addition, some contracts contain a provision for advance notice before termination of employment.

Where no contract exists between chemist and employer, the rights of each are governed by the nature of the employment. An excellent review of the law on this subject appears in *American Law Reports,* 1933, Vol. 85, page 1512, from which it will be seen that the courts have generally leaned far toward protecting the rights of inventors. It is probably safe to say that only where one is specifically "hired to make inventions" does the employer have title to them, while if the inventor's duties are in operating work, inspection, etc., his employer may have only a shop right

or nothing at all. Any inventions he may make in fields unrelated to his work are his own. Possibly the most important case on the subject is United States v. Dubilier Condenser Corp. (289 U. S. 178: 17 *U. S. Pat. Quarterly* 154; 85 *Am. Law Report* 1488) decided by the Supreme Court in 1933. In this case the inventors were engaged in testing and research work in the radio laboratories of the Bureau of Standards. While working on radio problems they made an invention pertaining to radio receiving sets, although specifically unrelated to the problem assigned to them. In denying to the employer the right to this invention the court said:

> "The respective rights and obligations of employer and employee, touching an invention conceived by the latter, spring from the contract of employment.
>
> "One employed to make an invention, who succeeds, during his term of service, in accomplishing that task, is bound to assign to his employer any patent obtained. The reason is that he has only produced that which he was employed to invent. His invention is the precise subject of the contract of employment. A term of the agreement necessarily is that what he is paid to produce belongs to his paymaster. * * * On the other hand, if the employment be general, albeit it covers a field of labor and effort in the performance of which the employee conceived the invention for which he obtained a patent, the contract is not so broadly construed as to require an assignment of the patent."

Obviously, borderline situations can arise where it is difficult to determine the rights of the respective parties and for this reason it is usually desirable to have a clear understanding in writing in the form of a contract, which could be called an "invention contract" but which is usually called an "employment contract."

For the benefit of both chemists and employers alike, it has seemed worthwhile to review the subject of employment contracts and perhaps suggest a form of contract which can be adopted in principle by those employers who do not now have a contract with their chemists but wish to have one. It could also serve as a guide to those employers who now have contracts they wish to revise. For this purpose a committee has been appointed to study the situation and a beginning has been made by collecting a number of employment contracts now in use. It will be of great help to the committee in its work if it can be supplied with bona fide copies of contracts employed by members of the Institute. These should be mailed to Vanderveer Voorhees, Chairman Employment Contracts Committee, 910 S. Michigan Avenue, Chicago, Illinois. Any personal information contained in

such contracts will, of course, be kept strictly confidential.

Some contracts provide for thirty or sixty days notice by either party before termination. Some contracts have no restrictions on the field of employment of the chemist after termination. Possibly this difficult subject should be left entirely to professional ethics with no attempt being made to hedge the employee with legal restrictions. A chemist who is trained in a particular specialty should not be asked to contract away the right to practice that specialty on which his livelihood depends. For example, real injustice would result from the enforcement of the following provision found in one contract:

> "It is expressly agreed by the undersigned for and in consideration of his employment by the said Company and the salary which the Company agrees to pay: That all knowledge and information which the undersigned now possesses or which he hereafter acquires regarding such methods and machines (of the Company), and all inventions and discoveries made by the undersigned pertaining thereto during the term of his 'employment and *for five years thereafter* shall at all times and for all purposes be regarded as acquired and held by the undersigned in a fiduciary capacity and solely for the benefit of the said company'."

Character of Employment

Since the most important function of the employment contract for chemists is usually the disposition of inventions, our chief interest here is to determine how this should be done in a manner both equitable and practical. To be equitable, chemists should probably be divided into two classes—those employed to invent and those not so employed. The first class will include research chemists, research directors, development engineers and any one whose time is spent directly on the improvement of products or processes. The second class will include analysts, routine workers, inspectors and operators. The inventions of the first class could be considered the property of the employer on the ground that the inventor was paid specifically for making them, whereas the second class of chemists, having received no consideration for their inventions, should keep title to them, with, perhaps, a shop right or non-exclusive license to the employer where the invention was developed with or applied to the employer's machine or process.

Practically, it is not always easy to distinguish between these two classes of chemists, creative and noncreative, and often the same man works at both kinds of jobs or is transferred at intervals from one job to another, for example from research to analytical and back. Thus it is difficult to provide a simple contractual arrangement

which will be just and fair to both parties, and this partly explains why employers have frequently cast all doubts aside and put all chemists under contract, including the helper in the inspection lab who makes up the reagents and gets $20.00 a week (prewar basis). It's always easy to solve a difficulty by accepting the other fellow's rights and although a sharp line cannot easily be drawn between these classes of chemists, a more equitable distinction certainly can be made.

Field of Invention

It is often the case that a person having an inventive faculty will not succeed in restraining his inventing to the field of his employer's business but will frequently make inventions in another chemical field entirely, or even in a mechanical field. Such inventions are better left to the inventor to patent and promote since the employer is either not interested in them or has not the facilities for their development.

When such unrelated inventions are excluded by contract, the practical question arises as to who shall decide in borderline cases whether or not a particular invention relates to the business of the employer. Should a dispute result it could be settled by a disinterested third party to be designated in the contract. Perhaps a committee of one of our national chemical societies could serve the chemical industry by arbitrating such qustions.

Special Incentives

Another question which is entirely distinct from that of fair employment contracts is the question of rewards for inventions as an incentive to greater interest in research and creative thinking.

Many employers, recognizing the value of patents in their business, offer special rewards to inventors. Some pay nothing or only a small assignment fee for all inventions regardless of value and proceed on the theory that promotions will be a sufficient reward to stimulate invention. But when this type of reward fails to materialize, as it often does, the reaction on the individual and on the laboratory as a whole is essentially bad for creative work.

This subject was discussed in an excellent article by John Boyle in the Journal of the Patent Office Society for July—1944—page 446 who concludes:

> "A partial solution to the patent problem is to give the inventor more. In giving the inventor more, a monetary bonus, award or premium is not the answer. Only by letting the inventor become a partner in the profits and savings from the patented invention is the reward in compliance with the intent and spirit of the Constitution. In the controversy that rages around the patent system, the inventor seems to be the forgotten man."

How to accomplish this result is the problem. In modern business the importance of leaving the employer a free hand in making cross licenses and other patent arrangements to keep the business operating unhampered cannot be overlooked. Some compromise could undoubtedly be made whereby, in case of a cash sale or license, the inventor would receive a portion of the proceeds, while in the case of inventions put to use by the employer or others, thru cross license, the inventor would be rewarded in proportion to the value of the improvement, as determined by a committee selected for the purpose. Teamwork in the laboratory could be promoted by sharing the benefits among the inventor's associates.

It is hard to see how an employer can fail to profit greatly by a well devised plan giving inventors a share in their creative work. Granted, there are difficulties in administration of such a plan. The benefits, however, will probably far exceed the cost. Furthermore, by giving the inventor a real interest in his brain child, inventors in big industrial laboratories will be largely relieved of the stigma of being only "captive inventors"* and patents originating in such laboratories will regain some of their lost dignity.

Suggestions for the solution of the problems of administering a commensurate reward system will be welcomed by the committee. The problem is most difficult in large laboratories where cooperation and free exchange of information is essential to maximum progress.

*Judge Arnold in Potts v. Coe 60 U. S. Pat. Quarterly 226.

Heyden Chemical Develops "M.D.A."

Heyden Chemical Corporation announces the development of a new dibasic acid, known as M.D.A. It is a technical grade of methylene disalicylic acid (dihydroxydiphenylmethane dicarboxylic acid), and consists of a mixture of isomers, with probably small amounts of low-molecular weight polymers.

M.D.A. is used in the manufacture of paints, varnishes, and protective coatings.

E. Dare Bolinger, M.A.I.C., formerly with the Celanese Corporation, Cumberland, Maryland, is now research director for the John R. Wald Company, Huntingdon, Penna.

Irving Hochstadter, F.A.I.C., has opened a consulting office at 52 Vanderbilt Avenue, New York, N. Y.

Donald Price, F.A.I.C., spoke on January 26th before the New York Academy of Sciences at its meeting held at the American Museum of Natural History. Dr. Price's subject was "Certain Aspects of the Chemistry of Surface Active Agents."

Invention and the Oil Industry

Gustav Egloff, F.A.I.C.

Universal Oil Products Company

Reprinted from "Petroleum Refiner," October, 1944.

THE oil industry of the world has reached its greatest development in the United States. This growth has been achieved largely through the incentive to invent, and the protection to inventions afforded by the American patent system. In fact, the oil industry's tremendous importance in the war rests squarely upon inventions protected by patents. The manufacture of adequate amounts of 100 plus aviation gasoline for fighter, bomber, and transport planes has involved the use of many inventions for producing its ingredients. Toluene needed for TNT manufacture has been made available through the application of new processes. Synthetic rubbers and a multitude of other products have had to depend to a great extent on processes stemming from inventions in petroleum refining. The protection given by our patent system has encouraged the enormous amount of research that fashioned the oil industry into a mighty war weapon.

In 1859 the completion of the Drake well marked the beginning of the oil industry and the kerosine age. Drilling of other wells, the transportation, storage, and refining of the oil into marketable products immediately presented an array of new problems which required the exercise of the inventive faculties of many men for their solution. New tools, new equipment, and new processes followed, which made possible drilling at increased depths, safer storage, more rapid transportation, and the breakup of the crudes into better kerosines, lubricants, and waxes. The patent records of this early period show how the publication of each new step stimulated further inventions, both in oil refining and in related fields, such as the manufacture of kerosine lamps.

From its modest beginning of 25 barrels a day, the oil industry has grown in the United States so that it is now producing about 4,700,000 barrels daily. At the present time the petroleum business represents an investment of over $15,000,000,000. This growth was stimulated by patent protection.

Finding Uncertain

The first step in industry, that of finding the oil, is always an uncertain undertaking in which there are many

more failures than successes. However, in this initial phase of the industry invention has eliminated some of the uncertainty which the wildcatter faces in his search for new fields. Geological, geophysical, electrical, and chemical methods have been invented which are exceedingly helpful in locating possible oil-bearing structures. Even now, after locating a potential oil field by all available methods, the driller may bring forth oil, gas, hot water, or nothing. In 1937, 1 out of every 10 wildcat wells produced oil, while in 1942, as more scientific methods of exploration were used, the ratio of producing wells had so increased that 1 out of 6 wildcat wells yielded petroleum. As further inventions are made, the finding of oil will become more certain.

The first well drilled for oil in the United States produced at a depth of 69 feet. Today, wells are producing at depths of over 2½ miles, and others have penetrated the earth's crust for about 3 miles, although the latter have thus far been dry holes. Reaching these depths has been made possible by the invention of specialized drilling machinery. Whole new industries have been developed to supply the mechanical equipment and chemicals needed in this work, and inventions have been encouraged in fields far removed from petroleum. Bits made from alloys of exceptional hardness, developed through years of research, bore through all kinds of structures at high speeds. These tools are cooled by special colloidal mud mixtures which serve also to control the well pressure. Methods for drilling wells in any direction and to any level desired have been invented so that formations at different depths can be tapped from the floor of a single derrick. As many as 13 different oil horizons are found in some fields. It took inventiveness of a high order to make possible the drilling of wells 3 miles deep without deviating more than 2 degrees from the vertical.

Breaking Emulsions

In the production of crude oil, water or brines are generally encountered. As oil and water come up through the well pipe together they form emulsions, presenting another difficulty which has been overcome by invention. Of a total 2,250,000,000 barrels of crude oil produced throughout the world in the war year 1943, an estimated 500,000,000 barrels were persistent oil-water emulsions of various types. Many of these are extremely difficult to break, but the oil must be separated from the water before it is refined. Invention has also trimphed over this problem. No one method has been found satisfactory for all oils. Physical, chemical, electrical, and mechanical processes have been successfully adapted to resolving the various types of emulsions into oil and water.

Special Storage Tanks

The advent of low-boiling petroleum products has necessitated the development of special types of storage tanks to hold them. Inventors have found this field to be a fertile one for their ideas. Tank storage for crude oil and gases at wells, refineries, and bulk stations has also called for constant research. Some storage reservoirs hold as much as 3,000,000 barrels of crude oil. Floating roofs and breather devices conserve gasoline. Spherical and spheroidal tanks have been invented for the storage of liquefied hydrocarbon gases under pressure. The largest spherical tank in use today is 60 feet in diameter and holds 20,000 barrels under pressure of 60 pounds per square inch. Spheroidal tanks of 155-foot diameter have been built to hold 120,000 barrels of gasoline. Such tanks are used to store butanes, butylenes,and butadiene, raw materials for aviation gasoline and synthetic rubber.

Pipe lines provide a method of transportation peculiar to the oil industry; they were developed exclusively by it, and developments in this field are not yet at an end. The process of centrifugal casting has been employed to make stronger pipe. Many methods have been developed for preventing internal and external corrosion of the pipe. Machines for wrapping pipe lines with tar saturated fabrics are used, and systems of cathodic protection are employed in acid and alkaline soils. Long sections of field pipe lines are periodically cleaned out by forcing cleaner plugs ahead of oil or water.

The transportation of oil by tankers from the Gulf to the Eastern seaboard was seriously curtailed by submarine activity during the early part of the war. To overcome this situation, the largest pipe line in the world, 1500 miles long, was built in record time and now conveys 300,000 barrels of crude oil per day. It extends from Longview, Texas, to New York. The pipe line is 24 inches in diameter and is equipped with specially designed oil pumps of huge size. The completion of this project would have been impossible without the previous researches and inventions which speeded the laying of the line through swamps, over mountains, and under roads and rivers.

Most Baffling Mixtures

Crude oil is one of the most baffling mixtures found in nature. Its physical characteristics are extremely variable, and its chemical composition is exceedingly complex. Early research occupied itself chiefly with the efficient physical separation of the components of these mixtures, but the inquiring inventor soon found that such separations were not the complete solution of the problem of obtaining the greatest values from petroleum.

In the early years of the petroleum industry, the values inherent in crude oil were neither fully recognized nor utilized. Simple distillations sufficed

to fractionate the kerosine, naphtha, and gas-oil as principal products from the crude. Other physical separations were used to recover lubricating oil, wax, and asphalt from the residue in the small amounts called for in that period. The fractions of the crudes were put to their most obvious uses without thought of their conversion into new types of products not yet in demand.

Development of Automobile

The principal and most readily marketable product was kerosine for lamps. This first supplemented and later supplanted the inadequate supplies of whale and fish oils, and oils produced from coal and shale, so that this period was known as the "kerosine age." Gasoline in this era had no commercial value to speak of, and what could not be forced into the kerosine fractions was burned or dumped into the rivers. This hazardous practice accounted for some serious fires. As a shortage of kerosine developed, a part of the crude oil was thermally cracked at relatively low temperatures and pressures to increase the yield.

In 1895 there were but four motor vehicles registered in the United States. However, production increased rapidly, and it may be said that the "gasoline age" began about the turn of the century. The inventions which made possible the commercial development of the automobile, and the rapid expansion of the automotive industry, put pressure on the oil industry to invent processes for the manufacture of more gasoline and better lubricants. Through its inventions the oil industry was able both to produce more crude and to increase the yield of motor fuel from each barrel. The increased supplies of gasoline made possible the expansion of the automotive industry. Inventors in the field of engines for automobiles, busses, and trucks have been engaged in bringing out new engines requiring higher antiknock fuels and better lubricants than those formed underground by nature. The new engines spurred the oil industry to still greater efforts to meet their demands.

Airplanes Stimulate Engine Development

From 1900 to 1941 the number of motor driven vehicles in the United States had increased from 8000 to around 33,000,000. This difference accounts for the correspondingly great increase in demand for motor fuel. The total production of gasoline from crude oil in 1900 was around 8,000,000 barrels, while in 1941 it was over 640,000,000 barrels. In 1900, a greater proportion of the gasoline produced was used for other purposes than automotive fuel, a fact which accounts for the apparent discrepancy in the consumption per car between 1900 and 1941.

At about the same time that the automobile became a potent factor in the national economy, the airplane

became a reality and began to seek its place in the sun. Although the results of the Wright brothers' first flight in 1903 with a heavier-than-air machine were not as immediate and widespread as in the case of the automobile, the airplane was an epoch-making invention. From its humble beginning it could scarcely have been predicted that the airplane would at some time enable the democratic nations to survive.

The initial success of the airplane greatly stimulated inventors in the field of aircraft engines and plane designs. As a result of their many inventions we have the magnificent planes of today which have so altered our way of life. Not alone within the borders of the aviation industry, but in many other industries as well, have inventors labored to supply the increasing demands of air travel. Under the impetus of the present conflict the airplane and airplane engines have undergone extremely rapid development, and the oil industry has responded to the demands for high-octane fuel and super lubricants by inventing new processes.

In 1903 there was but one airplane in the United States. As late as 1927 the total number of airplanes manufactured was 1785. Under the stimulus of war, production of military airplanes increased rapidly to 12,636 in 1940, 49,000 in 1942, and 86,000 in 1943. At the present rate, United States production in 1944 will be about 95,000 planes. However, numbers alone do not tell the whole story. The size and carrying capacities of planes have undergone great increases. On this basis it has been estimated that the 1943 production actually more than doubled that of 1942. There seems to be no limit to the size of projected aircraft. The Hughes-Kaiser 400,000-pound flying boat which is now approaching completion, will carry over 125,000 pounds. Far larger planes are in the making.

Crude Produced in the U. S. and Average Volume Percent Yield of Products Per Barrel of Crude

(M = 1,000 Barrels)

	1900		1920		1940	
	M Bbls.	Percent	M Bbls.	Percent	M Bbls.	Percent
Crude oil	63,600	100	443,000	100	1,352,000	100
Products:						
Gasoline	8,210	12.9	114,000	25.7	591,000	43.7
Kerosine	36,600	57.6	44,200	10.0	77,000	5.7
Lubricating oils	4,840	7.6	39,800	9.0	37,800	2.8
Distillate oils	—	—	—	—	192,000	14.2
Heavy oils	8,910	14.0	221,500	50.0	330,000	24.4
Miscellaneous	5,010	7.9	23,500	5.3	124,200	9.2

The aviation industry is still impelling the oil industry to invent processes for making both gasoline and lubricants that have still better performance characteristic in airplanes. This mandate has provided a high incentive for new researches. Practically all aviation gasoline is made by catalytic processes, and a great percentage of the components of aviation-fuel blends are synthetics.

The change in the quantities of products from petroleum during the transition from the "kerosine" to the "gasoline age" is shown in the preceding table.

Gasoline Yield Increase

The percentage yield of gasoline from crude oil almost quadrupled between 1900 and 1940, and the total volume of gasoline increased 75 times. The yield of kerosine from crude in the same period decreased from 57 to 5.7 percent, although the total volume of kerosine doubled because of increased crude-oil production. The percentage of lubricants from crude went through a maximum of 9 percent in 1920 and dropped to about 3 percent in 1940, although the total volume was about the same in 1920 and 1940. This constancy in lubricating-oil volume, in the face of greatly increased numbers of automobiles and other motor vehicles, is accounted for by better qualities of lubricants, their more efficient use, and recovery systems for used oils.

The need for more gasoline spurred inventors to redouble their efforts to solve the problem of producing greater yields from crude oil. The patents of the period are a record of their signal achievements in this direction.

The outstanding fruit of inventiveness at this time was the Burton thermal batch cracking process and its successor the Burton-Clark process, both of which went into commercial operation about 30 years ago. These processes were successfully used for many years. However, only the more selected gasoil fractions of the crude could be converted into gasoline with a yield of about 30 percent. These processes were the first step in a long march. Step 2 was the invention of the Trumble process which was the first to give relative continuity to the cracking process, but could not produce gasoline commercially unless the charging stock was gasoil and the yields thereof limited to within the same range as the Burton and Burton-Clark, and which was exemplified in such processes as those licensed by the Jenkins Petroleum Company. The following step was the invention and perfection of the Dubbs clean-circulation cracking process which, as compared with Burton-Clark or Trumble, more than doubled the yield of gasoline from crude oil by cracking heavy residues as well as gasoil in a continuous manner, and which superseded all its predecessors.

Since its commercialization, the thermal cracking of oil has conserved

about 20,000,000,000 barrels of crude petroleum, which is about our present estimated oil reserve. Had it not been for the cracking process it would have been necessary to produce 45,-000,000,000 barrels of crude oil instead of the 25,000,000,000 actually produced. The quality of the cracked gasoline produced has been far superior to that of the natural product, and more actual power has been obtained from gasoline engines than the increase in gasoline indicates.

Gasoline derived from the distillation of crude oil has an average octane rating of about 52, while in contrast, thermally-cracked gasoline has a rating of about 70. Cracked gasoline of this latter octane rating gives a 25 percent greater power output than nature's product when used in motors designed for it. This conserves a corresponding amount of fuel. A further increase in octane rating from 70 to 80 makes possible another 13 percent increase in power and a proportionately lower fuel consumption. Continually increasing octane numbers, brought about by the application of new inventions to the manufacture of gasoline, have made possible the development of high-compression engines which power war-planes.

To meet the demands for higher octane numbers, research men turned their attention to breaking down petroleum molecules and recombining the fragments to produce structures having forms and sizes better suited to the engine. Having solved the problem of supplying motor fuel in sufficient quantity, the inquiring light of research was turned toward still further improvement in quality, and to the development of totally new products.

While thermal cracking, continually improved and kept up-to-date, is still an important factor in the refining industry, far-seeing research leaders years ago sensed the fact that thermal cracking had its economy limitations as to the quality of the gasoline which it could produce; accordingly they pioneered in the investigation and study of a factor new in refining, namely, catalysis.

Catalysts

Early catalytic cracking processes used a variety of catalysts. Notable among these were aluminum chloride and the oxides of iron and other metals. In subsequent developments aluminum silicate minerals were employed, and still later, silica-alumina complexes of an active and at the same time a refractory character were invented. The need for developing catalysts has challenged the ingenuity of many inventors, and the catalysts which they have made have had a profound effect on the war effort in producing increased amounts of 100-octane aviation fuel and synthetic-rubber hydrocarbons. In 1938 the total consumption of aviation fuel in the United States by military, commercial, and privately-owned planes

was 2,391,629 barrels, a rate of about 6500 barrels a day. The average octane number was about 83. In December, 1941, at the outbreak of war with Japan, production of aviation gasoline was around 40,000 barrels a day, while at the present time warplanes are being supplied with more than 500,000 barrels daily, much of which is of 100-plus-octane quality.

Methods of catalyst utilization in cracking have also undergone extensive modifications. Four types of processes are now in commercial operation, the static bed, moving bed, fluid flow, and slurry. Many inventors have contributed to the commercial success of catalytic cracking.

Catalytic cracking produces gasoline of 80-octane number or higher, and gives better yields than thermal cracking. The gases from catalytic cracking contain considerably greater amounts of isobutane, the key hydrocarbon needed in the production of alkylate for aviation-fuel blends.

Cracked gasoline produced either by thermal or catalytic processes has a tendency to oxidize in storage, producing gum which impairs the operation of engines. Inventors who attacked this problem developed powerful chemicals known as inhibitors, which protect gasoline from degradation during long periods of storage by preventing formation of gum and preserving the anti-knock value. The use of inhibitors has materially assisted in the conservation of petroleum, since it has obviated the necessity of extensive chemical treatment of cracked gasolines and has conserved valuable anti-knock properties. About 75 percent of all gasolines now contain inhibitors.

Improved Lubricants

Research and invention in the petroleum industry have developed new and improved types of lubricants for a wide variety of uses. Highly refined oils are used in bearings of watches and precision instruments. Special high-pressure lubricants are available for machines where pressures may be many tons per square inch. Lubricating oils for highspeed diesel engines contain added detergents to wash tarry deposits from rings and cylinders, and to prolong operating periods. Airplane lubricants have been developed which are equally effective at tropic heat above 120° F. and at stratosphere cold more than 60° below zero, so that our fighter and bomber planes may function equally well in either extreme of temperature. The petroleum industry has a lubricant for every use.

The cracking process is the basis for the development of other processes because it furnishes large amounts of reactive hydrocarbons, both gaseous and liquid, for use in further syntheses. Cracked gases contain ethylene, propylene, and butylenes, which are absent in natural gas. For years these gases were used as fuel under boilers and stills. However, a few years ago a process for catalytic polymerization of these hydrocarbons was

invented which produced superior gasoline of 80-82 octane. This was an advance in the conservation of crude oil since this type of gasoline, when added to a lower grade, increases the octane rating of the latter so that it burns with high efficiency in motors. The catalytic polymerization process operating on cracked gases under selective conditions yields isooctenes. Upon hydrogenation of these isooctenes, a gasoline of about 95 octane is produced which is one of the components of 100-octane gasoline for planes.

Alkylation

Extremely important processes in the war effort which called for great inventiveness in their development are concerned with the alkylation of isobutane with olefins to produce high-octane-rating aviation alkylate. Ipatieff and Pines, working in the laboratories of Universal Oil Products Company, first showed that paraffins could be alkylated with olefins, and invented a process for alkylating isobutane. Other research workers were stimulated to invent processes for effecting this reaction and as a result of their researches the sulfuric-acid and hydrogen-fluoride processes came into commercial use. Catalytic processes for isomerizing normal butane to increase the available isobutane have also been developed, as well as processes for isomerizing normal pentane to isopentane and normal hexane to isohexane. Cumene, a hydrocarbon used in aviation fuel, is made by alkylating benzene with propylene.

Another process of great import in the war is the manufacture of aromatic hydrocarbons by dehydrogenation and cyclization. Other processes effect the catalytic dehydrogenation of naptheen hydrocarbons to produce aromatics, such as benzene and toluene.

Toluene from Petroleum

Toluene formerly was produced solely as a by-product of coal carbonization in the production of metallurgical coke for steel plants. In World War I, the maximum toulene production was at the rate of 15,000,000 gallons a year, and practically all of it came from coal carbonization plants. The toluene production from coal in World War II is at the rate of over 25,000,000 gallons a year. According to published reports, toluene requirements now approximate from 250,000,000 to 300,000,000 gallons a year which produce 3,000,000,000 pounds of TNT. The bulk of this comes from petroleum, through the inventiveness of chemists and chemical engineers in the oil industry. If it were not for these outstanding inventions for the manufacture of toluene, there would be a shortage in TNT production. The amount of coal that would be required to produce from 250,000,000 to 300.000,000 gallons of toluene would be about 300,000,000 tons. The oil industry has been so successful in pro-

ducing toluene that there is a present excess over explosive requirements, which is being added to aviation fuel blends to augment the supply and to raise their anti-knock quality.

Rubber

A special field of invention is concerned with the development of processes and catalysts for dehydrogenating butane to butylenes or to butadiene. These processes have largely assisted in the growth of the rubber industry in the United States. Copolymerization of butadiene and styrene gives Buna-S rubber for tires, and the polymerization of isobutylene and a small amount of isoprene produced from petroleum gives butyl rubber. This last material is expecially good for inner tubes. Tests have shown that in a tire at 40 pounds pressure, the loss is only 0.08 pounds a week, or 4 pounds pressure in a year. When completed and operated at full capacity the plants for producing butadiene from petroleum hydrocarbons will supply from one half to two thirds of synthetic rubber requirements. As a result of the efforts of numerous inventors and researchers in the United States, the processes for the manufacture of synthetic rubber were available in this country when the war started.

Increased supplies of distillates from crude oil and cracking processes have promoted the use of these oils for house-hold-heating purposes; consequently, many new inventions of oil burners and furnaces have resulted. The increased supplies of heavier residual oils have also stimulated the invention of improved types of burners and furnaces for use under boilers and heating units of industrial plants. Inventions in this field have greatly aided in the conservation of oil resources.

Metallurgical Advances

It is difficult to overestimate the influence that the cracking process and auxiliary processes have exerted on building new and enlarging old industries. A branch of metallurgy has developed a large number of special alloy steels to withstand the effects of high temperatures employed in cracking. An outstanding development in this line is the class of nickel-chromium alloys, which are resistant, not only to heat, but also to the corrosive effects of sulfur and oxygen. In order to control and regulate cracking and auxiliary processes in respect to temperature, pressure, and rates of flow, a large industry for the manufacture of special instruments has been built up. The availability of reactive olefins, aromatics, and isoparaffins from cracking and allied refining processes has furnished bases for the manufacture of an ever-increasing line of chemical derivatives. The manufacture of synthetic rubber has been aided by the production of butadiene and styrene, and the plastics industry has been furnished many raw materials.

The increased supplies of gasoline

from cracking have promoted the automobile and airplane industry, and lessened the cost of both the manufacture and the operation of automobiles, trucks, busses, and planes. Large manufacturing enterprises stem from the automotive industry. Metals, fabrics, plastics, glass, electrical equipment, paints and enamels, and many other essentials have undergone increases in production to supply materials used in the manufacture of automobiles.

Our increased warplane output has also furthered the development of new processes for making radios, cameras, bomb-sights, stabilizers, gyroscopes, and a multitude of other instruments essential in combat flying and precision bombing. Without gasoline, many of these industries would never have come into being. The increase in industrial employment directly traceable to the development of cracking and allied processes is thus extremely large.

Spur of War

Under the spur of war necessity, the best scientific and technical minds in the industry sought and found the solution of various problems in many processes which have the standing and dignity of invention. Missing links were forged and processes which would have waited years for commercial development in the normal course were designed and put into successful operation almost overnight. To understand the importance of these processes it is only necessary to know that almost every drop of 100-plus-octane gasoline that gives our flyers dominance in the air, is primarily produced by catalytic processes.

American inventions in aviation gasoline processes gave the R.A.F. 100-octane fuel, and tactical superiority over the Luftwaffe in 1940. This made possible the winning of the Battle of Britain, and turned the course of history. Without our research and developments in motor-fuel manufacture, fostered by the patent system, the United Nations might well have lost this war.

Just as oil finding is an unusually adventurous and costly project, the uncertainties of research and development in manufacturing processes have been great. There are also many dry holes in oil-refining research. A large number of inventions may be made and a great deal of research conducted in attempting to develop a new and useful process before producing anything commercially successful. Great as the achievements have been in development of both thermal and catalytic cracking processes, it is well to remember that over $500,000,000 was spent in research and development projects, and in plants which were commercial failures. It may be asked what impelled the inventors in these fields to drive on in the face of such discouragement. The driving force was the incentive offered by our patent system. Certainly, rewards

should be forthcoming to successful processes based on invention after the expenditure of time, energy, and capital.

Development of Inventions

There is an idea in circulation that inventions result from quick flashes of thought which may be considered as either sudden inspirations, or more or less fortuitous guesswork. Nothing could be further from the truth. Worthwhile inventions are produced by the same "blood, sweat and tears" made famous by the eminent Prime Minister of Great Britain.

Patented inventions benefit the consuming public, industry, and research. The inventor has full rights to his invention during a 17-year period. After this the patent becomes public property and may be used by any citizen. When a patent issues, industry is informed of the new development embodied in the patent and often recognizes a commercial trend wherein patentable improvements are possible. Whole new industries have been developed based on patented processes in oil refining. Research is fostered in that its findings can be protected, and publication of results can be more complete and widespread, thus cutting down duplication of work and furnishing a basis for further study and experimentation. Anyone can purchase a copy of a patent for 10 cents.

The patent specification gives complete and detailed information as to the nature of the invention. Without patent protection, research would be driven underground and secret processes would develop. Chaos would reign in business and industry, and piracy of processes and methods would become common practice. Systems of espionage would develop for getting information on new processes and products, so that they could be used by competitors without consideration of inventors' rights. Manufacturing concerns could easily be put out of business by such thefts. Under such conditions it is questionable whether small businesses could survive. Those employed in industries would be enjoined from normal discussion of their work either inside or outside of their company, and cooperative research efforts would be frustrated. This would result in slowing up invention, if not in eliminating the United States from world leadership in industry, which it has held for many years under the patent system. One invention always promotes others, and inventors react catalytically on one another.

Patent Ownership

The ownership of patents is the inducement for capital to invest in the promotion of new processes and products. Without patent protection, companies could not afford to take the risks inherent in research work. Neither would they feel justified in financing research foundations at universities where much work of a fundamental character is carried out if

they could not be assured of rights in developments. Licensing of patented processes in the oil industry is widespread, and small and large refiners use them. Thus the use of new processes becomes diffused more widely among large and small companies. The small refiner is able to operate patented processes which he would have no chance to develop by his own research, and so is able to compete with large companies and, often, to produce products at a lower price.

Without the active exploring faculty of the American inventor, these developments would not have been possible.

What applies to the oil industry also applies to other industries. Industrial processes and relationships are extremely involved and frequently influence one another. The inventions of one industry stimulate inventors in apparently unrelated fields. Inventions have cut down the amount of physical labor necessary in manufacturing processes, without promoting unemployment. In fact, inventions have increased employment. The products of inventions, such as the automobile and the airplane, also save labor while providing more jobs. Inventions bring about competition which keeps industry young by constantly producing new processes and materials. Inventions mean low-cost products.

It is difficult to visualize the kind of oil industry we would have today without the inventor and the United States patent system. So little progress would have been made that in comparison it would seem like a throwback to the beginnings of the industry. Our whole social and economic system would be on a far lower plane if we did not have our patent system. The lack of petroleum products for automobiles, diesel engines, railways, marine transportation, airplanes, industrial plants, and military machines would be disastrous to our way of life. However, we have been safeguarded through our collective inventive genius and our patent system, so that our oil supplies are ample for every essential need of the present and the future.

The post-war period will see research and inventions developing at a tempo far greater than before World War II. All civilized countries are aroused to the importance of research, inventions, and patents; not alone in the war effort but in the peacetime to come.

Emil Ott, F.A.I.C., director of research of Hercules Powder Company, spoke in January before the Baton Rouge and Louisiana sections of the American Chemical Society. Dr. Ott's subject was "The Relation of Physical Characteristics and Chemical Structure of Cellulose Derivatives."

Affens Transferred

Wilbur A. Affens, M.A.I.C., has been transferred from his position as assistant chemist with the War Department in Cincinnati to the Department of Agriculture, War Food Administration, Office of Distribution, Livestock and Meats Branch, Insecticide Division, to be stationed in New York, N. Y., after a period in Beltsville, Maryland.

Hercules Subsidiary

Hercules Powder Company announces the creation of a subsidiary, Hercules Powder Company, Ltd., for the distribution of information on its products in Great Britain and Eire. Headquarters of the subsidiary will be at 140 Park Lane, London, under the direction of Cornelius H. B. Rutteman.

Necrology

Thomas W. Bacchus

Thomas W. Bacchus, retired vice president and director of Hercules Powder Company, died December 30th, in Wilmington, Delaware, at the age of eighty-two. Mr. Bacchus directed the Hercules Company's explosives production program during World War One. He joined the Hercules Powder Company in 1893, six years after his arrival in this country from England. He retired on February 1, 1941, as vice president and director of Hercules.

Harry Phillips Trevithick

Harry Phillips Trevithick, chief chemist of the New York Produce Exchange, died suddenly on Wednesday, January 17, of a heart attack in the Bowling Green Subway Station while enroute from his office in the Exchange Laboratories to his home at Baldwin, Long Island. He was fifty-eight years old.

Born in New Britain, Connecticut, he was the son of Wm. J. and Mrs. Minnie Phillips Trevithick. He was graduated from Wesleyan University, Middletown, Connecticut in 1907 and from Massachusetts Institute of Technology in 1910.

From the time of his graduation until 1915 he was district chemist of The Southern Cotton Oil Company and Refuge Cotton Oil Company at Vicksburg, Mississippi. After a short period with the U. S. Department of Agriculture at Washington, he joined the staff of the Produce Exchange Laboratory in November, 1915, becoming chief chemist and consultant in 1917. Under his management the

Exchange Laboratories increased in size and scope and in prestige throughout the world, specializing in grains, flour, bread, edible oils and fats and soaps.

Mr. Trevithick was particularly versed in the chemistry and technology of the fatty oils, glycerine and soaps and had published many technical and scientific papers on these subjects. He was active in many scientific societies, including the American Chemical Society, Association of Official Agricultural Chemists and American Society for Testing Materials. He was a member and past president of the American Oil Chemists' Society, a Fellow of the American Institute of Chemists, chairman of the Committee on Soap Specifications of the American Society for Testing Materials, a member and past president of the Association of Consulting Chemists and Chemical Engineers. He was a Licensed Professional Engineer of New York State.

Mr. Trevithick was for many years until very recently organist and choirmaster of the First Baptist Church at Rockville Center, Long Island, also organist of Floral Park Lodge and Bedford Lodge, Brooklyn, F. and A. M. He was a member of Massapequa Lodge and of the Scottish Rite at Rockville Center. He was a member of Sigma Chi college fraternity and formerly a member of the Chemists' Club, New York.

Mr. Trevithick was married in 1907 to Miss Katherine D. Coe of Middletown, Connecticut, who survives him together with two sons, Harry P. Jr. of Oceanside, L. I. and Lt. Douglas C., AUS, at present a Bombardier in the South Pacific, a daughter, Mrs. Theodore C. Messler, of Baldwin, L. I. and one granddaughter. His father, mother, a brother and a sister, all of Connecticut, also survive him.

—Alan Porter Lee

Kenneth J. Howe

Kenneth J. Howe, vice-president, Thibaut and Walker Co., Long Island City, New York, died January first, in Postgraduate Hospital, New York, N. Y.

Mr. Howe was born in Mt. Vernon, New York, November 3, 1897 and was a graduate of Williams College. In 1909 he became president and chief chemist of the Howe Varnish Company, Brooklyn, N. Y., which was merged in 1920 with the Thibaut and Walker Company. Mr. Howe was the author of various articles in trade journals on paint and varnish chemistry, and was past president of the New York and New Jersey Paint and Varnish Production Club and past president of the Federation of Paint and Varnish Production Clubs. He became a Fellow of The American Institute of Chemists in 1936.

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January Meeting

THE 217th meeting of the National Council of The American Institute of Chemists was held on Friday, January 26, 1945, at the Building Trades Employers' Association Club Rooms, 2 Park Avenue, New York, at four p. m., President Gustav Egloff presiding.

The following officers and councilors were present: Messrs. S. R. Brinkley, G. Egloff, H. L. Fisher, F. A. Hessel, W. H. Hill, H. B. McClure, R. J. Moore, J. F. Muller, H. S. Neiman, F. D. Snell, A. L. Taylor and Mr. Toch. Mr. Arthur Schroder and Miss V. F. Kimball were present.

The minutes of the preceding meeting were approved.

The treasurer's report was read and accepted.

Mr. H. B. McClure, as new councilor, was introduced to the Council meeting.

Upon motion made and seconded, the action of the committee on Annual Meeting to hold the meeting in Columbus, Ohio, on May 11th and 12th, with headquarters at the Deshler-Wallick Hotel was approved. It was suggested that the general theme of the meeting be the contributions chemists can make to further the war effort.

The report of the Committee on Constitutional Revision was presented and accepted.

The report of the Jury on Medal Award was presented, and upon motion made and seconded, John W. Thomas, chairman and directing head of The Firestone Tire and Rubber Company, was awarded the 1945 medal of THE AMERICAN INSTITUTE OF CHEMISTS.

Dr. Hessel announced that some time next month there will be a hearing before a Senate committee regarding the extension of the convention date used in filing foreign applications for patents. Upon motion made and seconded the Council authorized Mr. Neiman to act between now and the next meeting of the National Council, where such action would seem to be desirable on the part of the Institute.

The secretary read a letter from Mr. T. S. McCarthy concerning advertising in THE CHEMIST.

The matter of a general manager of the INSTITUTE was discussed further and action deferred until a later meeting of the Council.

Upon motion made and seconded the following new members were elected:

Fellows

Ansbacher, S.

(1945), *Scientific Consultant,* American Home Products Corporation, 350 Fifth Avenue, New York, N. Y.

Bowman, John R.

(1945), *Industrial Fellow,* Mellon Institute, Pittsburgh, Pennsylvania.

Curtis, Francis J.

(1945), *Vice President,* Monsanto Chemical Company, 1700 South Second St., St. Louis, Missouri.

Gershon, Victor P.

(1945), *Consulting Chemical Engineer,* 500 West 11th St., New York 25, N. Y.

Gilbert, Everett E.

(1945), *Supervisor, Organic Division,* General Chemical Company, 40 Rector Street, New York, N. Y.

Hedrick, Glen W.

(1945), *Research Chemist,* E. F. Houghton and Company, 303 W. Lehigh Avenue, Philadelphia, Pennsylvania.

Johnson, Harry I.

(1945), *Chief of Research,* American Viscose Corporation, Roanoke, Virginia

Joseph, Glenn Howe

(1945), *Chemist in Charge, Corona Laboratory, Research Department,* California Fruit Growers Exchange, Corona, California.

Kean, Robert H.

(1945), *Technical Director, Chemicals Division,* Virginia-Carolina Chemical Corporation, Richmond 5, Virginia.

Kunz, Walter B.

(1945), *Research Chemist,* Sylvania Industrial Corporation, Fredericksburg, Virginia.

McConnell, Henry K.

(1945), *Vice-President in Charge of Manufacture,* Tobacco By-Products Chemical Corporation, Richmond 6, Virginia.

Oliensis, Gershon L.

(1945), *Chief Chemist & Director of Research,* Babbitt-Barber Asphalt Products, Inc., Madison, Illinois.

Riethof, George

(1945), *Research Chemist,* Pittsburgh Coke & Chemical Company, Grant Bldg. Pittsburgh 19, Pennsylvania.

Stasse, Henry L.

(1945), *Research Chemist,* Barrett Division, Allied Chemical & Dye Corporation, Research Laboratory, Edgewater, N. J.

Members

Boyd, Robert B.

(M.1945), *Technical Sales, Market Research and Development,* Oldbury Electro-Chemical Company, 22 East 40th Street, New York, N. Y.

Burkard, Perle N.

(M.1945), *Research Supervisor,* Wyandotte Chemicals Corporation, Wyandotte, Michigan.

Saffir, Jacob A.

(M.1945), *Head of Research in Organic Chemistry & Synthetic Resins,* Dentists' Supply Co. of New York, 220 West 42nd Street, New York 18, N. Y.

Taylor, Robert L.

(M.1945), *Editor, Chemical Industries,* 522 Fifth Avenue, New York 18, N. Y.

Scheer, Walter E.

(M.1945), *Sales Manager and Assistant to the President,* Amecco Chemicals, Inc., 60 East 42nd Street, New York 17, N.Y.

Sexton, Edwin L.

(M.1945), *Research Chemist, Cereal Division,* The Best Foods, Inc., 54 Fulton Street, Buffalo, N. Y.

Springer, Stewart

(M.1945), *Technologist,* Reed-Martin Laboratories, Inc., Box 992, Ft. Myers, Florida.

Wymbs, Roy P.

(M.1945), *Research Chemist,* Sylvania Industrial Corp., Fredericksburg, Va.

Associates

Davis, Evan E., Jr.

(A.1945), *Chemist,* Sun Oil Company, Marcus Hook, Pa.

Hubanks, Paul E.

(A.1945), *Assistant Chemist,* U. S. D. A., Bureau of Entomology and Plant Quarantine, Beltsville, Maryland.

Jehle, John A., Jr.

(A.1945), *Chemist,* Socony-Vacuum Oil Company, Research and Development Division, Paulsboro, New Jersey.

Levine, Herman S.
(A.1945), *Research Assistant,* Illinois State Geological Survey, 100 Natural Resources Building, Urbana, Illinois.

Shafer, Myra E.
(A.1945), *Chemical Secretary,* Celanese Corporation of America, 290 Ferry St., Newark, N. J.

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Council Representative, Louis N. Markwood
Reporter to THE CHEMIST, T. H. Tremearne

A meeting of the Chapter was held December 13th at the Wardman Park Hotel, Washington, D. C., at which new officers were elected for the coming year, as shown above.

The meeting was devoted to a discussion of the aims and policies of the Chapter. Plans were made for three meetings to be held in February, March and April.

Western Pennsylvania

President, Henry G. Goodman, Jr. *Vice-president*, Henry F. Smyth, Jr.
Secretary-Treasurer, Jacqueline S. Front
Mellon Institute of Industrial Research
Pittsburgh 13, Penna.
Council Representative, William H. Hill

For Your Library

VALENCY, CLASSICAL AND MODERN By W. G. Palmer. Cambridge, at the University Press. The Macmillan Company, 242 pp. 5" x 8". $2.50.

Valency is fundamental to chemistry in that it is a necessary inference to account for the existence of discreet entities of matter. This small volume is crammed with data on the measurement of valence by chemical, stereochemical, electric moments, spectral, and high frequency radiation methods.

The present day topics on valency, such as complex ions, bond energy, molecular orbits and hydrogen bonds constitute the latter half of the book. Of interest is the observation that a consequence of the Mathematical Principle of Uncertainty in atomic structure is that it permits an explanation of why valence bonds preserve a mutual direction in space.

This book contains an assemblage of good information.

—J. A. S.

Dr. Otto Eisenschiml's article "Post War Enemy Number One" which appeared in the September issue of THE CHEMIST was reprinted in *The Accelerator,* publication of the Indiana Section of The American Chemical Society.

Gaylor to Publish *Technical Survey*

Peter J. Gaylor, F.A.I.C., has resigned from the Standard Oil Development Company to enter into private practice, specializing in patent law, trade marks and copyrights. He will also publish *Technical Survey,* a weekly service covering new developments and trends in technology. His address is 1121 Kinney Building, 790 Broad St., Newark 2, N. J.

Interchemical Review, Winter-1944, features articles on the "Evolution of Mills for Grinding" and "The Rheological Concepts of Viscosity and Yield Value."

"Labors of War for Peace" is the title of a twenty-two page booklet of reprints of Hercules Powder Company advertisements in color, which tell the story of Hercules products.

The Chemical Publishing Company, Inc., 26 Court Street, Brooklyn, 2, N. Y., announces that a new catalog of technical books is now available to readers of THE CHEMIST.

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SCIENCE! True Daughter of Old Time thou art!
Who alterest all things with thy peering eyes.
Why preyest thou thus upon the poet's heart,
Vulture, whose wings are dull realities?
How should he love thee? or how deem thee wise,
Who wouldst not leave him in his wandering
To seek for treasure in the jeweled skies,
Albeit he soared with an undaunted wing?
Hast thou not dragged Diana from her car?
And driven the Hamadryad from the wood
To seek a Shelter in some happier star?
Hast thou not torn the Naiad from her flood,
The Elfin from the green grass, and from me
The summer dream beneath the tamarind tree?

—EDGAR ALLAN POE

John J. Grebe, F.A.I.C., director of the physical research laboratory of the Dow Chemical Company, spoke recently before the American Institute of Chemical Engineers at The Engineers' Club, Philadelphia, on "Tools and Aims of Research." He urged that increased educational opportunity, more efficient devices for living, and a minimum standard of living be a goal through the achievements of research.

Information Wanted

THE AMERICAN INSTITUTE OF CHEMISTS:

We would appreciate any information you can give us concerning the planning and equipping of a chemistry laboratory for the use of groups of teen-age youngsters.

There is a growing interest in this field among the boys and girls participating in our program, and we would like to be able to provide them with authoritative material to guide them in setting up their laboratories.

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John H. Yoe, F.A.I.C., of the University of Virginia, is speaking before the Blue Ridge Section, American Chemical Society, Blacksburg, February tenth, on "Inorganic Analysis with Organic Reagents."

Dr. Yoe has fostered research in this field in numerous colleges in Virginia, and is co-author of a text in this field.

Clemente Catalano, importers and exporters, 200 Rua Sao Bento, Sao Paulo, Brazil, wish to represent American manufacturers on a commission basis, or will import American products, particularly industrial chemicals and fine chemicals.

Scientific Military Research Needed in Peacetime

Rear Admiral J. A. Furer, U.S.N., coordinator of research and development, U. S. Navy Department, spoke recently before the Industrial Research Institute on "Post-War Military Research." Scientists, he stated "can play an important part in the work that should be done during the peace period following this war to develop the weapons for the next war . . . I think that Americans are now ready to face the fact that the war to end all wars has not yet been fought."

The committee headed by Charles E. Wilson, consisting of four scientists, four representatives of the Army, and four representatives of the Navy, recommends that the highest level of scientists in the United States be made available to the armed services in time of peace as consultants on military research. This can be achieved by a permanent board composed of civilians of distinction in science, engineering, and industry, and of military officers who have responsibilities in connection with research and development work.

Admiral Furer concluded, "Stocking our arsenals with the weapons of this war is no guarantee that we can win the next war with them . . . It would be wiser to maintain arsenals of only modest size whether we are speaking of ships or guns or aircraft and to use the money saved thereby to continually replace the old things with the new creations of the research laboratory and of American inventive genius . . . Expenditures for research must henceforth be a substantial part of our peace-time preparedness program."

Mr. Howard S. Neiman, Secretary
THE AMERICAN INSTITUTE
OF CHEMISTS:

This will acknowledge, with thanks, receipt of your letter advising me that my application for life membership in THE AMERICAN INSTITUTE OF CHEMISTS has been approved. I am happy to be identified with this group which, in my opinion, exhibits in the highest degree the American pioneering spirit. In any of the activities of the INSTITUTE for which my qualifications fit me, I shall be happy to participate.

—JOHN A. DIENNER, F.A.I.C.

Meeting Dates

Feb. 9. Meeting. Chicago Chapter. THE AMERICAN INSTITUTE OF CHEMISTS. Huyler's Restaurant, 310 South Michigan Ave., Chicago. Speaker: Arthur Schroder, Chemical Analyst, Alien Property Custodian, Chicago. Subject: "Taking the I.G.'s I. Q." From a study of

the property of the I.G., the office of the Alien Property Custodian has been able to deduce much about the workings of the I.G. Mr. Schroder will tell how we may use this information to our own advantage.

Feb. 15. Baltimore Chapter, The American Institute of Chemists. Speaker: Harry Darroch, Industrial Corporation of Baltimore. Subject: "Importance of Human Relations in the Coming Era."

Feb. 15. Meeting Los Angeles Chapter, The American Institute of Chemists, Clark Hotel, Los Angeles, Open forum discussion, "Defects of the Chemist."

February 26. Meeting. Washington, D. C. Chapter, The American Institute of Chemists. Wardman Park Hotel. Speaker: Dr Gustav Egloff, President, A.I.C.

Feb. 27. Pennsylvania Chapter. The American Institute of Chemists. Engineers' Club, Philadelphia. Speaker: Dr. Gustav Egloff. President, A.I.C., "The Chemists' Role in a World at War."

Mar. 15. Meeting. Baltimore Chapter. The American Institute of Chemists.

Mar. 21. Meeting. Washington, D. C. Chapter, The American Institute of Chemists. Wardman Park Hotel.

Mar. 23. New York Chapter of The American Institute of Chemists 26th Floor. No. 2 Park Avenue, New York, N. Y. Speakers: Dr. Elmore H. Northey, Pharmaceutical Division, Calco Chemical Division of American Cyanamid Company, "The Therapeutic Implications of the Sulfa Drugs"; Dr. Walter Modell, Cornell University Medical College, "Recent Developments in Antibiotics."

Mar. 27. Pennsylvania Chapter. The American Institute of Chemists. Engineers' Club. Philadelphia. Speaker: Dr. Foster D. Snell, President, Foster D. Snell, Inc. "The Factors in Detergency."

Apr. 18. Meeting. Washington, D. C. Chapter, The American Institute of Chemists. Wardman Park Hotel.

Apr. 18. Joint Meeting. Pennsylvania Chapter. The American Institute of Chemists, and Philadelphia Section, The American Chemical Society, Engineers' Club, Philadelphia. Speakers: Dr. H. G. Byers, F.A.I.C., "Soil Genesis and Some Soil Properties."

Apr. 19. Meeting. Baltimore Chapter. The American Institute of Chemists.

Apr. 27. New York Chapter of THE AMERICAN INSTITUTE OF CHEMISTS. Student Medal Presentation, 26th Floor, No. 2 Park Avenue, New York, N. Y. Speaker: Professor Alexander O. Gettler, Toxicologist of the City of New York, "Contributions Chemistry has Made in the Detection of Crime."

May 11-13. Annual Meeting. THE AMERICAN INSTITUTE OF CHEMISTS. Deshler-Wallick Hotel, Columbus, Ohio. Medal Award to John W. Thomas, chairman and directing head, The Firestone Tire and Rubber Company. Program to be announced. Dr. E. L. Luaces, chairman of Committee on Arrangements.

May 17. Dinner and Business Meeting. Baltimore Chapter. THE AMERICAN INSTITUTE OF CHEMISTS. Northway Apartments, Baltimore, 6:30 p. m.

May 21-23. Sixth Annual Conference of the Institute of Food Technologists. Hotel Seneca, Rochester, N. Y.

May 25. New York Chapter of THE AMERICAN INSTITUTE OF CHEMISTS. Annual Business Meeting. 26th Floor, No. 2 Park Avenue, New York, N. Y. Speaker: Dr. Wanda K. Farr, Celanese Corporation of America, "Utilization of Plant Cell Membranes."

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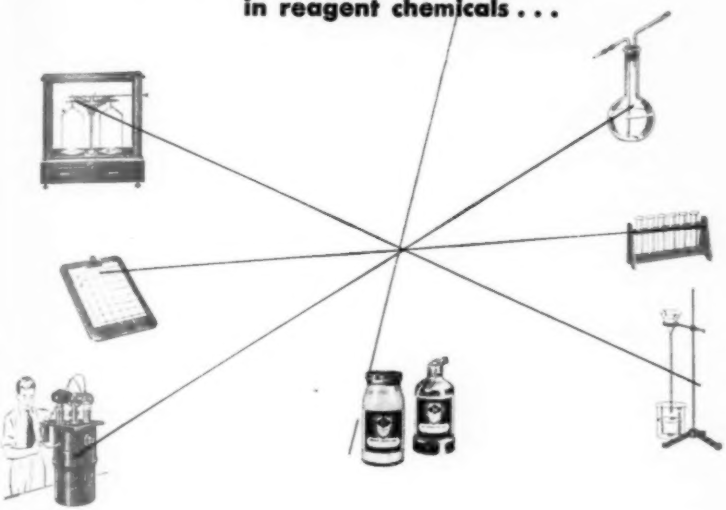

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